Charles Batchelor Notebook, Cat. 1306

This notebook covers the period September 1883-July 1884. Most of the entries are by Charles Batchelor. The book contains notes, drawings, calculations, and graphs relating to lamps and dynamos. There are approximately 120 unnumbered pages.

1. Friction Metal.

Metal for heavy weights & high speed.

Tin	35
Zinc	50
Lead	10
Antimony	5
	100

Antifriction metal

Copper	5
Zinc	85
Antimony	10
	100

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2. Sept 4 1883

Section wire in armature –

In armatures made with wires you must have a section of wire 0·18 mm for each lamp of ·75 ampere then

Lamps	Section	Amperes
1	·18	·75
6	1·	4·5
1·25	·225	1

3. Unit of Magnetic field Jan 1884

that strength of field that will give 1 volt in 1 metre of wire cutting it at 1 metre in 1 second

M = unit of magnetism

L = total length of wire that cuts the field of force and it is found by. length of field × 2 × number of blocks ÷ 2 if multiple used

V = Velocity of cutting speed turns Rev × Diameter ÷ 60 for second.

then $E = M \times L \times V$

and $M = \frac{E}{L \times V}$

Now as 200 light gives 110 volts at 1200 turns we can get the magnetism from the following:-

$$\cancel{M = \frac{110}{280 \times 2 \times 14} \times \frac{1200 \times \cdot 246}{60}}$$

$$M = \frac{E}{L \times V} = 110 \div \left(\frac{\cdot 280 \times 2 \times 14}{2}\right) \times \left(\frac{1200 \times \cdot 246}{60}\right) = \frac{110}{101 \cdot 5} \text{ or about } 1 \cdot 08$$

Now the magnetism of the old 60 light L would be as follows:-

$M = \frac{E}{L \times V} = 110$ ohms

$$\frac{\cdot 24 \times 4 \times 44}{2} \times \frac{1200 \times \cdot 251}{60} =$$

$$\frac{110}{178 \cdot 31} = \text{about } \cdot 62\%.$$

In the 200 light the percentage of Section of Core to section of head is 56% and the current passed round the magnet is

$$\frac{110}{45} \times 14 = 34 \cdot 16 \text{ amperes.}$$

In the old L the percentage is

$$\frac{213820}{60240} = 35\tfrac{1}{2}\%$$

and the current passed round the magnet was

$$\frac{110}{42} \times 4 = 18 \cdot 34 \text{ amperes.}$$

New 100 light machine

Quest. 1 Have we enough section for lamp?

Yes. C = 75 amperes. we have 6 wires 2 times round of 14/10 =

1·53 × 6 = 9·18 + 9·18 = 18·36

75 Amperes ÷ 18·36 = 4 amperes about

Dia = 1·08 then

$E = M \times L \times V =$

$= 1{\cdot}08 \times \frac{250 \times 2 \times 64 \times 1350 \times 748}{2 \quad 60} =$

1·08 × 16 × 3·35 = Volts 8·4·54

I forgot that the wire is twice round + then divided by 2

= Volts 15·08

4 New 100 light Dynamo.

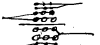
Feb. 20 1884

Armature :-

64 Blocks.

6 Wires of 14/10 twice round

Iron core 250 × 148



Magnet :. 250 × 150 cast Corners of 50 mm radius –

Section 35354

Section of armature iron cut away 37848. therefore percentage is $\frac{35354}{37848} = 91\%$

Current round magnet is 27 amperes or 4·84 × 16 layers.

Length of magnet.

60 ohms of 12/10 = 70·24 metre

× 60 = 4214 metre.

or 210·7 metre for each coil

$\frac{210{\cdot}7}{15} = 14{\cdot}0$ metre each layer

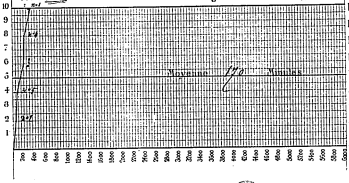
Perimeter of core with 1/2 layers on = ·789

$\frac{110 \text{ metre}}{\cdot 789} = 144$ turns.

·0112 + ·0004 × 144 = ·283 length of core.

Copper on magnets 42 Miles or ·420 per amp.

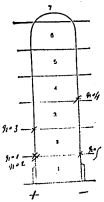
N° 1 Essai à 10. Bougies



Lampes	4 à 10. bougies	
Fabrication	23 Janvier 1884	
Dimensions	5 x —	
Intensité normale	10 bougies	
	2 10 bougies	2 10 bougies
Rés à chaud	1,73.9	1,79.9
Volts	94.6	115.2
Courant en Amp.	2,995	2,701
Kilogrammètres	5.6	10.2
Lamp Chev. vapeur	51.2	7.3
Durée moyenne		

4460 - 49 m

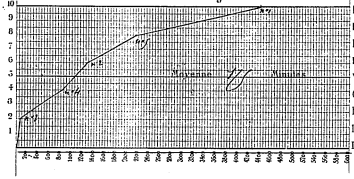
1/9



1° — 31f Meinetter.
2° — 50
3 — 20f
4 — 26g
5 — 7L

469. 24 juin

N° ..... Essai à 64 Bougies



Lampes	A16 Hans de Ricky	
Fabrication	13 Février 76	
Dimensions	6 x 0.03 x 0.14	
Intensité normale	16 Bougies	
Rés. à chaud	723-8	114.5
Volts	98	111.1
Courant en Amp.	0.791	1.019
Kilogrammètres	75	11.95
Lamp Chev. vapeur	9.85	5.68
Durée moyenne		

N° 3. Fils de platine soudés
au fils —
Verre brisé

N°	Abo Minutes
2	126
3	15
4	82
5	217

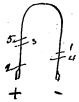
7. Lamps. 22 Feb 1884

3" × ·007 × ·0135" –

8 Bougies & 32 bougies

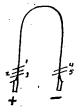
Hydrogen 258 cubic = 684 heures.

	8 bougies	32 bougies
Res.	67.03	61.59
Volts	51.3	63.
Amp.	·766	1.023
Relgn	3.93	6.51
Lamps par Ct.	19.5.	11.5



1 — 456 minutes
2 — 18
3 — 231
4 — 464
5 — 122
5/1291
258 minutes

8 Lamps B16. (No 35)



Made. 19 May 83	1	— 303
" Jan 1884	2	— 136
March 83.	3	— 284
May 83	4	337
Feb. 1884.	5	75
		5/1139
		228 minutes

At 64 candles

	Rest. Volts.	Amp.	Wtg	H.P.
16 CP	32.32.	46.58	1.47	7	10.5
64 CP	34.08	57.1	1.95	11.7	6.3.

228 × 2.65 = 604 hours.

~~Feb.~~ March 4 1884

9 We must make a lamp of 68 Volts and 16 candle power

·008 × ·0135" Carbon = ·000108"

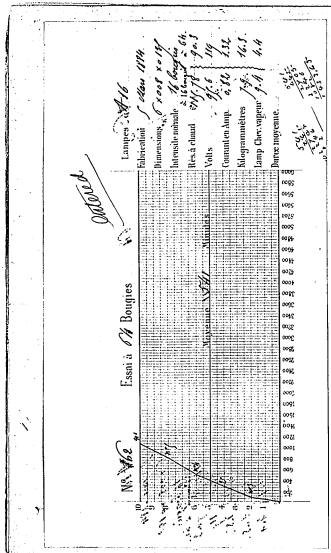
Resistance per Centimetre 24·20 ohms.

·008" = 0·2032 m m
·0135 = 0·343 " "

·2032 × ·3429 = ·0697 m m section

1" ÷ ·0697 = 14·352.

$\frac{24.20}{14.352}$ = 1·609 ohm Resist per m m per centimetre long.



8 X 13 fibre takes 1 volts for every ·0015 m

6 P volts = ·80 amp = 85 ohms.

fibre 8 X 14 section = ·2032 X ·4318 = ·0877 m.m

Surface of $\frac{P}{13}$ = 1·0922 m.m X 152·4 m = 156·45 m.m.

156·45 ÷ 16 = 9·77 m.m per candle.

∴ Surface same

Candle power same

Energy same

Smallest practical width 0·127 m.m

103 X ·75 = 77·25

∴ 6P X 1·13 = 77·25

Length — 34% = length ~~[illegible]~~ 152 = ·110 m.m

Section + 34% = section = ~~·0877 + ·0293 m.m~~ ·06088 + ·0236 = ·09327 m.m c

·25 × ·47

~~·2032 X~~

156·45 ÷ 110 long = 1·42 m.m round edge

We want 2 number that X together must make ·09327 m.m

·53 × ·18 110 m.m

No 1 — 1048 minutes
2 — 251 "
3 — 68 "
4 — 497 "
5 — 808 "

5 | 2706
541
265

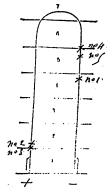
8 X 13½ fibre takes 1 volts for every ·0015 m
6 P volts ÷ ·80 ampere = 85 ohms.
fibre 8 X 14 section = ·2032 X ·4318 = ·0877 m.m
Surface of 1/13 = 1·0922 m.m X 152·4 m. = 156·45 m.m
156·45 ÷ 16 = 9·77 m.m per candle.

∴ Surface same
Candlepower same
Energy same
Smallest practical width 0·127 m.m
103 X ·75 = 77·25
∴ 68 X 1·13 = 77·25
length — 34 m = length 152 m. — ·110 m.m
section + 3 m = section = ·06708 + ·0236 = ·09327 m.m
·09327 m.m c

·25
·47

~~·2032 X~~
156·45 ÷ 110 long = 1·42 m.m round edge
We want 2 number that X together must make ·09327 m.m

·16 110·0 m.m
·53



No 1 — 1048 Minutes
2 — 251 "
3 — 68 "
4 — 497 "
5 — 808 "

5 / 2406
5 41
2 6 5
2 4 0 5
3 2 4 6
1 0 8 2
1 4 3 3 6 5

8 X 1½ fibre takes 1 volt for every ·0015 m
6 P Leclanché = ·80 ampere = 85 Ohms.
fibre 8 X 1½ section = ·2032 X ·4318 = ·0877 4176 m m

Surface of $\frac{8}{13}$ = 1·0922 m m X 152·4 m = 156·45 □ m m
156·45 ÷ 16 = 9·77 □ m m per candle.

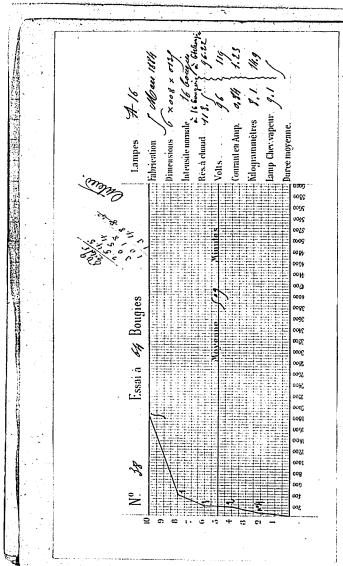
∴ Surface same
Candle-power same
Energy same
Smallest practical width 0·127 m m
103 X ·75 = 77·25
∴ 68 X 1·13 = 77·25
length — 34% = length ~~[illegible]~~ 152 = ·110 m m
~~·06066 + ·0236 = [illegible]~~
Section + 34% = section = ~~·0877 + [illegible]~~ ·09327 □ c

·25
·47

~~·2032 X~~

156·45 ÷ 110 long = 1·42 m m round edge
We want 2 numbers that X together equal make ·09327 □ c

·15
·53
110 m m



Tests Calculation

Length.	101.45 m m
Width.	.66285 m m
Thickness.	.15495 m m
Resist.	54.45 ohms.

$\frac{l}{a\,b} \times S_k = 125$:

$S/K = 56.18$ 68 Volts 16 candles

Surface 166.45

Length	100 m
Width	0.673
Thickness	0.15495
Resist	54.45 ohms

Jacks Calculator

Length.	101.45 m m
Width.	·66285 m m
Thickness.	·15795 m m
Resist.	54.75 ohms.

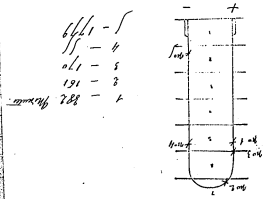
$\frac{l}{a\,b} \times \frac{1}{R} = 125$

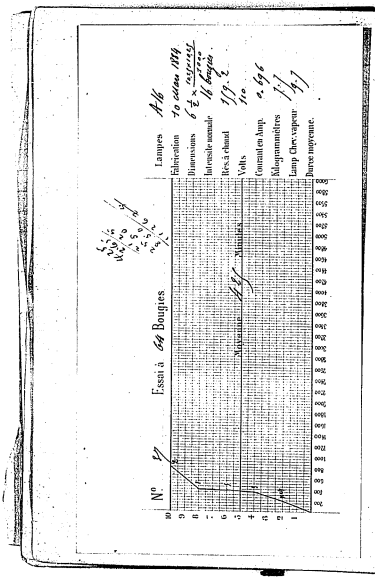
$1/R = 9648$

68 Volts 16 candles

Surface 166·45

Faraday	100 m
Width	0·673
Thickness	0·15795
Resist	54·75 ohms





Specific Resist = 0·0697 = 152 ohms.

·0697 X 14·347 = 1 ㎠ carb

∴ 152·4 : 125 ohm :: 1·000 : 820 ohms

820 ÷ 14·347 = 55·86 Specific Resistance of our Carbon

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103 X ·75 = Voltamperes = 77·25

68 X x = 77·25 = 68 X 1·133 = 77·25 Voltamperes

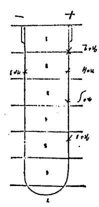
∴ Current = 1·133 amperes

$\frac{E}{C} = R = \frac{68}{1.133} = 60$ ohms.

152·4 X (·2132 + ·2032 + ·343 + ·343) = Surface 166·48 m m

·2032 X ·343 X 152·4 = 10·622 Solid content

$\text{Section} = \frac{\sqrt{10.622 \times 55.86}}{60} =$



No 1	400	Minutes
2	805	"
3	347	"
4	197	"
5	377	"

Specific Resist $= 0{\cdot}0697 = 152$ ohms.

$\cdot 0697 \times 14{\cdot}347 = 1$ carré

$\therefore 152{\cdot}4 : 125$ ohms $:: 1{\cdot}000 : 820$ ohms

$820 \div 14{\cdot}347 =$ 55·86 Specific Resistance of our Carbon

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$103 \times \cdot 75 =$ Voltamperes $= 77{\cdot}25$

$68 \times x = 77{\cdot}25 = 68 \times 1{\cdot}133 = 77{\cdot}25$ Voltamperes

$\therefore$ Currant $= 1{\cdot}133$ amperes

$$\frac{E}{C} = R = \frac{68}{1{\cdot}133} = 60 \text{ ohms.}$$

$152{\cdot}4 \times (\cdot 2132 + \cdot 2032 + \cdot 343 + \cdot 343) =$ Surface $166{\cdot}48$ m m

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$\cdot 2032 \times \cdot 343 \times 152{\cdot}4 = 10{\cdot}622$ Solid content

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$$\text{Section} = \frac{\sqrt{10.622} \times 55{\cdot}86}{60} =$$

Current	per % Section	Core Sec.		
15.25	48 %	10387		
26.84	67 %	16513	1500 Rev	
23.18	56 %	20106	1500 Rev	
18.34	35½ %			
28.06	46½	33006		
32.5	28	40212		
34.16	56 %			
49.27	33	60318		
68.32	47½	66012		
109.95	56 %	124644		

Mch. 12 1884

Magnetism on Edison Dynamos.

Machine	Length of WIRE	per Sec Velocity	Section	Ampères	M
17	36.48	4.143			.728
17					
25	57.6	2.82			68
50	47.52	3.8			.61
60	35.816	4.92			.68
100					
120	21.317	5.33			.967
150	53.244	3.485			.59
200	20.72	4.92			1.08
250	46.72	3.69			.638
300	30.51	3.69			.977
500					

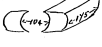
Berlin March 15 1884

Price Siemens Machines for incandescent lights (Compound) in Berlin

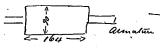
Type	Lamps (C)	Weight	Price
g D 16	12.	130 K	M 800
g D 17	25	210	1100 mk
g D 18	40	300	1600 mk
g E 8	75	—	—
g E 14	100	650	2500
g E 15	150	800	3600
g E 20	200	1270	4300

X Edison T machine 100 A lamps.

4 Cores. 258 long
126 Diameter
Ratio of section Head 80%



Each core 14 layers No 20 A.W.G.



Resistance 1 — 63·34
Siemens unit 2 = 61·59
3 — 63·70
4 = 64·20

190 X 140
Pulley

Armature Resistance
·0160 1
Siemens unit

Resultant magnets + armature of
H Machine from Newyork
6 cores 1 - 14.80
2 - 14.50
3 - 16.36
4 - 14.20
5 - 13.71
6 - 14.00
Armature .00224? 3 strands .02243.

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50 light machine american make
Magnet
54.4 Armature
48.7 .131

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25 light machine
31.6
34.0 Armature .3526

Calculation for incandescent lamp.

Take the ~~[illegible]~~ formation of a lamp of n candles at e volts when you have the measure of one of n candles and E volts then $e\,i\,n$ $s = a\,b\,l$ lamp given

" $E\,I\,R$ $S = A\,B\,L$ lamp to find

The luminous intensity must be the same the density of the current must be the same as $\frac{S}{I} = \frac{s}{i}$ or $\frac{A\,B}{I} = \frac{a\,b}{i}$

The quantity of light must also be the same because the surface is the same

$$(A+B)\,L = (a+b)\,l$$

If the economy must also be the same then $E\,I = e\,i$. $\frac{E^2}{R} = \frac{e^2}{r}$

$$\frac{E^2 AB}{L} = \frac{e^2 a\,b}{l}$$

Now admitting these we can proceed thus

$- \quad I = \frac{el}{R}$ $\qquad I = \left(\frac{e}{R}\right) i$

$- \quad R = \left[\frac{R}{I}\right] = \left[\frac{R}{el}\right] = \left[\frac{R}{e}\right] l$ $\qquad R = \left[\frac{R}{e}\right]^2 r$

$- \quad S = \left(\frac{I}{e}\right) s = \left[\frac{e}{E}\right] s$ $\qquad S = \left[\frac{e}{E}\right] s$

or $AB = \left[\frac{e}{E}\right] s$

$- \quad \frac{L}{SR} = \frac{l}{sr}$ $\quad L = \frac{e}{E} s \cdot \frac{E^2}{e^2} r \times \frac{l}{sr}$ $\qquad L = \left(\frac{E}{e}\right) l$

$- \quad (A+B) L = (a+b) l$ $\qquad A+B = \left(\frac{e}{E}\right)(a+b)$

Application :- To make a lamp of 16 candles & 68 Volts

Given $e = 105$ $\quad r = 125$ $\quad i = \frac{e}{r} = 0.84$

$a = \frac{13}{1000}$ $\quad b = \frac{9}{1000}$ or $a = 0.13$. $b = 0.205$. $l = 154$

$a \times l = .167$. $a + b = 0.335$

Result. $E = 68$ $\quad I\ 1.3$. $R = 52.42$

$S = .10797$. $L = 99.7$

$AB = .10797$ $\qquad A + B = .821$

$A = .656$ $\quad B = .165$

Quantity of light – for the same intensity – the quantity of light is proportional to the number of candles

$(A+B) L = \frac{N}{a}(a+b)$ –

$$\begin{array}{r} \cdot 2165 \\ \cdot 300 \\ \hline \cdot 07165 \\ 12\cdot 17 \\ \hline 36\,1\,5\,5 \\ 5\,1\,6\,5 \\ \hline 5\,1\,6\,5 \\ \hline 5\cdot 2\,5\,2\,8\,0\,5 \end{array} \qquad \begin{array}{r} \cdot 203 \\ \cdot 343 \\ \hline \cdot 5\,4\,6 \\ 1\cdot 12 \\ \hline 2\,7\,3\,0 \\ 5\,4\,6 \\ \hline 5\,7\cdot 3\,5\,0 \end{array}$$

General equation:

$$I = \frac{N}{n}\,\frac{e}{E}\,v \qquad I = \left(\frac{E}{e}\right) l$$

$$R = \frac{n}{N}\left(\frac{E}{e}\right)^2 r \qquad A + B = \frac{N}{n}\,\frac{e}{E}\,(a + b.)$$

$$AB = \frac{N}{n}\,\frac{e}{E}\,ab.$$

Wanted a lamp of 6 Volts and 10 Candles

Same cenny a. Ou 6 x 00F x 0125 —

Given $e = 103$ $r = 125$ $a = \cdot 203$ $b. = 0\cdot 343$

$l = 154$ $E = 68$ $N = 10$ $i = \cdot 224$

$$I = \frac{N}{n} \times \frac{e}{E} \times i = \frac{10}{16} \times \frac{103}{68} \times \cdot 224 = \cdot 965 \times \cdot 224 = \cdot 2165$$

$$R = \frac{n}{N}\left(\frac{E}{e}\right)^2 r = \frac{16}{10} \times \frac{68^2}{103^2} \times 125 = 16\cdot 25$$

$$I = \left(\frac{E}{e}\right) \times l = \frac{68}{103} \times 154 = 101\cdot 7 \text{ Ohm}$$

$$AB = \frac{N}{n} \times \frac{e}{E} \times ab. = \frac{10}{16} \times \frac{103}{68} \times \overset{\cdot 06965}{(\cdot 203 \times \cdot 343)} = 0\cdot 06968$$

$$A + B = \frac{N}{n}\,\frac{e}{E}\,(a + b) = \frac{10}{16} \times \frac{103}{68} \times (\cdot 203 + \cdot 343) = \cdot 5165$$

$A = \cdot 2165$ $B = \cdot 300$

It's evident that for the same luminous intensity the quantity of light is proportional to the radiating surface

I = length	l = length
Standard type $S = AB$ = section	$a - ab$ = section
I.E.R. = Elect. constants.	i.e.r. constants
N = candles	n candles
$D = \frac{I}{AB}$ = density of current	$d = \frac{i}{ab}$ = density of lamp to get

$$\frac{ci}{R} = \frac{EI}{N} \qquad \frac{(a+b)d}{n} = \frac{(A+B)D}{N}$$

$$\therefore \frac{ci}{EI} = \frac{n}{N} \quad \text{also} \quad \frac{(a+b)d}{(A+B)D} = \frac{n}{N}$$

As e & n are generally given we can say that

$$i = \left(\frac{n}{N}\,\frac{E}{e}\right) I \qquad r = \left(\frac{N}{n}\,\frac{e^2}{E^2}\right) R$$

$$l = \left(\frac{n}{N}\right) \times I$$

$$a + b = \frac{n}{N}\,\frac{l}{I}\,(A+B)$$

$$ab = \frac{n}{N}\,\frac{l}{I}\,\frac{E^2}{e^2}\,AB$$

$$\frac{l}{ab}\,\rho = \left(\frac{n}{N}\,\frac{e^2}{E^2}\right)\frac{I}{AB}\,\rho$$ ρ being a coefficient which takes into consideration new hot & shrinkage.

during carbonization we shall have

$$\frac{ab}{AB}\,\frac{l}{I}\,\frac{E^2}{e^2} = \frac{n}{N} \qquad \frac{a+b}{A+B}\,\frac{e}{I} = \frac{n}{N}$$

Law of incandescence – X

It seem to result from maps made till now that for the same luminous intensity the amount quantity of energy for candle is constant (if we keep the same surface for candle as we have in the 8 X 13½ filament we are sure of an life and if we give the same surface per candle for all lamps we are sure of life) Now on electromotive force being always constant the ampere will be proportional to the number of lamps

Then. $EI = N(ei)$ $\quad ei = n(ei)$

$$\frac{EI}{N} = \frac{ei}{n} \qquad E = e.$$

$$\frac{I}{N} = \frac{i}{n} \qquad \frac{I}{i} = \frac{N}{n} = \frac{A+B}{a+b}$$

$$\frac{R \times I^2}{r\,i^2} = \frac{N}{n} \quad \text{i.e.} \quad \frac{R}{r} = \frac{N}{n}$$

$$\frac{I}{i}\,\frac{ab}{AB} = \frac{n}{N}$$

i.e. $\frac{A+B}{a+b} = \frac{N}{n} = \frac{I}{i} = \frac{a}{A} = \frac{AB}{ab}\,\frac{i}{I}$

Then it results that the greater the section the larger it must be – for intensity of current being same the density of the current will be smaller

Then for a lamp of 50 candles the dimensions would be as follows:—

Given:- $e = 103$ $R = 125$ $i = \cdot 824$ $n = 16$

$a = \cdot 203$ $b = \cdot 343$ $l = 1514$ $ab \cdot 07 = \cdot 06969$

Given also:- $E \cdot 103$. $N = 50$

Then

$$R = \frac{n}{N} \cdot \frac{E^2}{e^2} a = \frac{16}{50} \times \frac{103^2}{103^2} \times 125 = \cdot 32 \times 125 = 40$$

$$I = \frac{N}{n} \times \frac{e}{E} \times i = \frac{50}{16} \times \cdot 824 = 2 \cdot 57 \quad 2 \cdot 6 \text{ ft. amp.}$$

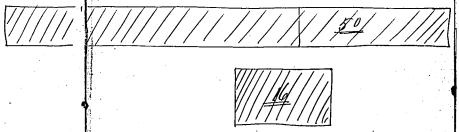
$$I_1 = \frac{E}{e} \times l = 1514 \text{ ---}$$

$$AB = \frac{N}{n} \times \frac{e}{E} \times ab = \frac{50}{16} \times (a \times b) = \cdot 21984$$

$$A + B = \frac{N}{n} \times \frac{e}{E} \times (a + b) = \frac{50}{16} \times (a + b) = \cdot 771$$

$$A = \cdot 140$$

$$B = 1 \cdot 570$$



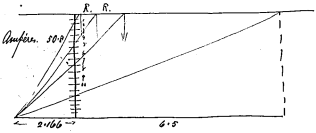
For 6 lbs

1 R = 13 = ohm

then 13 ÷ 6 = 2·166 total machine

2·166 × 3 = 6·498 or 6·5

then



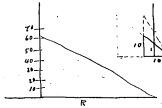
5

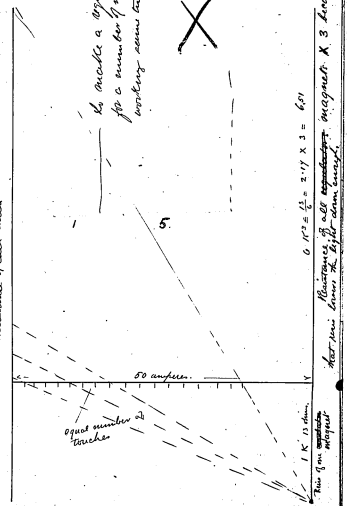
$$\begin{array}{r} 6.5 \\ 2.166 \\ \hline 3.666 \end{array}$$

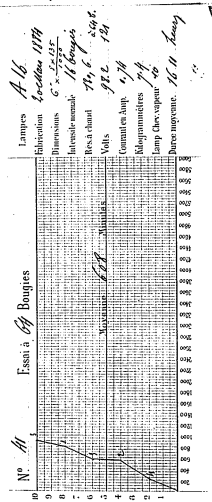
$$\begin{array}{r|l} 110 & \\ 2.166 & 50.8 \\ \hline 1.1 & \\ 1.1 & \\ \hline 1.0 & \\ 1.0 & \\ \hline 1.0 & \\ 1.0 & \\ \hline 1.0 & \end{array}$$

$$\begin{array}{r|l} 110 & \\ 3.666 & 30 \\ \hline 110.000 & \\ 36.66 & \\ \hline 73.340 & \end{array}$$

Volts







Febres:- 6" × .008" × .0135"

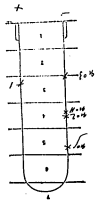
Average of	20.	159.6	×	287.1
"	40	159.6	×	286.3
"	60	160.	×	283.1
"	80	159	×	282.4
"	100	158.9	×	281.8
"	120	158.8	×	282.9
		956.2	×	1703.6

Average. 6" × .007968" × .014197"

6½ × .008" × .0135"

20	—	162	×	240.
40	—	160.5	×	263.2
		160.6		242.1
		161		241.4
		161.1		241.6
		162.		240.6
		964.2		1618.9

155 – 5
172 – 4
176 – 5
191 – 3
191 – 108 Fluorescence



Fibres:- 6" × ·005" × ·0130" X

Average of	20.	159·6	×	284·1
"	40	159·6	×	286·3
"	60	160·	×	283·1
"	80	159	×	282·4
"	100	158·9	×	281·8
"	120	158·8	×	282·9
		956·2	×	1423·6

Average. 6" × ·004968" × ·014197"

6½ × ·005" × ·0135" — 20 — 162 × 270.

40 —	160·5	×	263·2
	160·6		272·1
	161		271·4
	161·1		271·6
	162·		270·6
	967·2		1615·9

Gouck St Newark May. 16 1844

Heat radiates from Armature of Edison Machines per inch of Surface

H Machine (new) at 400 amperes.

R on Armature (effective) =

·013 x 76% = ·0099 ohms

Current 400 amp

Surface inches = 1006

$400^2 \times ·0099 = 1584$ heat units

$1584 \div 1006 =$ 1·57 HU per inch

S Machine at 184 amperes.

R armat ·022 x 63% = ·0138 ohm

Surface 544 inches

$184^2 \times ·0138 = 467$ heat units

$467 \div 544 =$ ·86 HU per inch

H. Machine at 325 amperes.

R. effective ·0099

$325^2 \times ·0099 = 1045$ heat units

$1045 \div 1006 =$ 1.03 heat per inch

New York May 16 1944

S machine at 200 amperes

R = ·0138

Surface 544 inch

$200^2 \times ·0138 = 552$ heat U

$552 \div 544 =$ 1.01 HU per inch

T Machine at 92 amperes.

R effective = ·043 × 67% = ·0467 ohm

Surface 324 inches

$92^2 \times ·0467 = 395$ HU

$395 \div 324 =$ 1.22 HU per inch

T Machine at 115 amperes.

R = ·0467

S 324 inch

$115^2 \times ·0467 = 617$ HU

$617 \div 324 =$ 1.90 HU per inch

C machine at 24 amperes

R = ·312 × 67% = ·209 ohm

Surface 177 inch

$24^2 \times ·209 = 120$ HU

$120 \div 177 =$ ·68 HU per inch

see page.

Lamps a Incandescence.

As we have decided that the surface per candle in the lamp of 16 candles cannot be decreased what is the best form of section that will use the least current?

(16 candle lamp section 0.203 X 0.343)

16 candle.	Section	Surface	
·203 x ·343	·069629	1.092	
·273 X ·273	·074529	1.092	

Density of current in each case:

$\cdot 203 \times \cdot 343 = \frac{1000000}{\cdot 069629} = 14.50 \times \cdot 75 =$ or 10.875

$\cdot 273 \times \cdot 273 = \frac{1000000}{\cdot 074529} = 13.42 \times \cdot 75 = 10.065$

Thus for 16 candle as we make it now the density of current is 10.875 ampere per millimeter square whilst with same surface with a square section we ~~so~~ have only 10.065 per mm carré.

50 light Machine of 500 Volts

Ordinary 50 light

$E = 110$ D ·152 N 4

M = ·61 C ·54 Resis ·486 ohm

L = ·220 R 1500 (Wire 12/10 [illegible])

outside diameter ·180

113 × 4 × 2 = 9·04 in sqrs.

40 amp ÷ 9·04 = 4·4 per sqrs in

Suppose 1 wire 16 times round.

then $E = M \times L \times V =$

$$·61 \times \frac{220 \times 4 \times 16 \times 54}{12} \times \frac{\overset{25}{1500} \times ·152}{\underset{1}{60}} =$$

$$·61 \times 190·08 \times 3·8 = 440·61 \text{ Volts}$$

Carrying 8 amperes 8 times be only 3 amp per 16 in circle

But volts not sufficient Resist 3 ohms

If I take 12/10 I can get 5 wires in same space as 40 of 12/10 in: (10 + 3 × 5 = 65) 12 × 3 × 4 = 6.0

the room I have is 152 × 3·14 = ·4774

·4774 − 2 × 54 for pins = ·369 ÷ 54 = 6·8 in

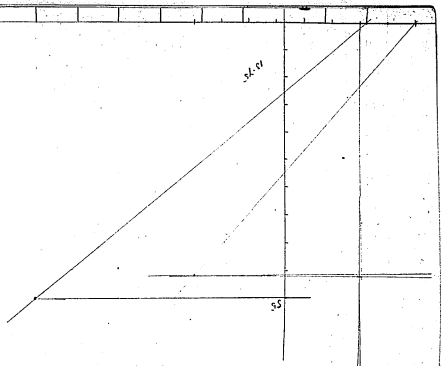
then N = 20

$$E = ·61 \times \frac{220 \times 20 \times 54}{12} \times 3·8 = ·61 \times 2376 \times 3·8 =$$

550 Volts

Resist. 5·25

2 Amperes 12/10 wire


55

R. machine at 46 amperes.

effective R = ·138 × 67% = ·0924 ohms

Surface 177 inches

$46^2 \times ·0924 =$ 195 HU

195 ÷ 177 = 1·1 HU per inch

Y Machine at 296 amperes

effect. R = ·0104 × 65% = ·00676

Surface 584

$\frac{296^2 \times ·00676}{584} =$ 1. HU per inch

Amperes & current per mm in the copper on Magnets

T $\frac{110}{1·159} \div 2·48 = \frac{77·21}{2·48}$ 31 mm

G $\frac{110}{61·75} \div ·62 = \frac{1·79}{·62} = 2·88$ " mm

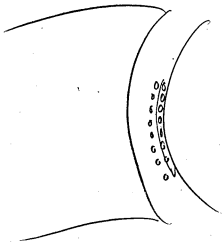
R $\frac{110}{23·9} \div 1·24 = \frac{4·6}{1·24} = 3·6$ per mm

S $\frac{110}{14·5} \div 3·4 = \frac{7·6}{3·4} = 2·24$ " "

Y $\frac{110}{1·53} \div 9·146 = \frac{9·92}{4·973} = 1·95$ " "

H $\frac{110}{8·55} \div 6·42 = \frac{13·53}{6·42} = 2·07$ " "

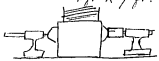
$\frac{E}{R} \div$ Section $= \frac{I}{S}$.



Newark. May. 17 1884

Machine of 250 amperes at 110 volts and 300 Revolutions

Space must not exceed 4 ft x 4 ft. + 6 ft high



to be left with shaft sticking out to connect to a motor –

Take 300 light cores ~~Order Obtained~~. 18¾" Diam x 21" long.

48 Divisions

Wound with 8 No 11 – 2 times round

~~Section = 4·3 x 8 = 34·4 m m.~~

~~34·4 x 2 = 68 m m~~

4 Wires twice round No 11 =

Amperes per m m.

~~4·2 x 4 x 2 = 250~~ ~~5·4 x 2 = 250~~

$$\frac{250 \text{ amperes}}{4.2 \times 4 \times 2} = \frac{250}{34.4} = 4.3 \text{ amp per m m}$$

Diameter of Commutator Blocks.

3·05 + ·3 x 8 = 26·8 m m.

~~Say 28 Mm.~~

Say 2 mm for Fibre = 28·8 each

18 3/4 inch diameter = 475 mm diameter
1147 ~~[illegible]~~ ÷ 22·5 = 52 cm block.

Length of wire
20 mm cow = 508 mm
18 3/4 " = 475 mm
L = 508 × 2 × 475 × 2 =
1966 × 52 = 102·23 metres

Resist = ·24 ohms
or multiple are ·06 ohm.

C.M.F.
E = N × L × V =
1 × 508 × 2 × 52 × 5/60 × ·475 =

1 × 52·83 × 2·375 = 125·48 volts

Heat radiates per 1 inch
R = ·06 × 58% = ·0312 rd
250² × ·0312 = 1956
Surface 1153
1956 ÷ 1153 = 1·7 heat units per inch

Seyffert. May 17 1884

Heat units per inch on Y machine

296 amperes

Arm. (18 x 9¾) 547 Sq. inch

Res. = ·0104 x 65% = ·00676

296² x ·00676 = ~~[illegible]~~ 1.08 H units

Magnetism on T Machine see Edison.

$M = \frac{E}{L \times U} =$

$120 \div \left(\frac{540 \times 6 \times 2 \times 60}{6}\right) \times \frac{1350 \times 490}{60}$

$\frac{120}{648 \times 4.27} = .43$

Section Rater = 330 x 178. — 41%

58740 Heat.

~~23950~~ Core

If we make $\frac{230 \text{ sq}^{\text{n}}}{41548}$ 71%

If we take 40 turn then we put 2.75 Ampere

In 18 Wire 6 Volts

~~Length 2280~~

~~Each core~~

2.75 Amp. 12 = 33.00

Circum 756

9304 feet = 40 turn

9304 ÷ 3.28 = 2830

÷ 2 = 1415

1415 ÷ 756 = 1890 / 12 | 1890 / 156 convolu.

156 x 1.65 =

Core 11½ x 9"

Wound with 12 Papers of No 18 Wire

Suppose 215 in a core

$\frac{36305}{58740} = 61\%$

1415 meter in 12 papers

9 inch = 230 m m diam

= 72 circum.

about 200 Convolution

for 12 papers. 163 convolution

#14 Wire 38 ohms 126 lb.

$\frac{110}{38}$ = 2·9 amperes

2·9 amps = 12½ capers.

13 capers

200 Convolution = 206

May 18 1884

Machine built by Colden

T – 100 amperes.

Armature 5·8 per ⊞ m.m.

Magnets 30·85 Resi.

#14 – 8½ capers. 2·79 Convol.

Wire diam ·058" outside ·070

Cores { 21½ X 7½.
540 X 190

% section { Arm. 13 X 7½ = 330 X 180
Core 28352
Head 59400 47%

Current Magnet.

3·5 X 9 = 31·5 amperes.

With an 8" core

204 Core Socta 32685
Arm. 59400 55%

With an 8½ core

215 = $\frac{36305}{59400}$ = 61%

$\frac{40828}{59400}$

9" core would be 67%

9" Core = 35 ohm wire #14

228 + 10 = 238

238 Circum = 748 m m

35 ohms #14 = 3478 metres

each core 1739 metres

$\frac{1739}{.748}$ = 2322 convolutions

~~24~~ 12 layers would be 3.14 x 12 = 38 amp

2322 ÷ 12 = 194 conv. to layer.

= 194 x 1.8 = 349 m m long core

116 ft. long

Then core 9" core 14 3/4 long.

Wound with 12 layers of #14 wire

May 18 1894

T machine at 100 amperes

.894 x 10 x 2 = 17.88

100 ÷ 17.88 = 5.6 amperes per ▨ m m

Radiation

$C^2 \times R$ = $100^2 \times (.0173 \times 62\%)$ =

$100 \times .0467$ = 467 HU

288 inches =

1.6 HU per inch

at 75 amperes .91 HU per inch

Z machine 54 amperes.

Current per ▨ m m

277 x 246

277
5.54
4.95
1046 / 5540 (0.53
5230
3100

$54^2 \times (.014 \times 53\%)$ = $54^2 \times .074$ = 216 HU

Inches. 306.1

.7 HU per ▨ inch

T Machine to carry 100 amperes
we must reduce armature
to ·05 ohms
How to do this !!!
Same length of No 18 wire would
be :— ·05 ohms

We can cut the plate 1/16
then diam = 4.186 +
Circum. 22.564 —
Now: 300 turns of ·065 = 19.500
60 Insul. fibre 250

R. Machine must be made
67% section & 38 amperes

now what is M on the $M = \frac{E}{L \times V} =$

$$\frac{110}{\frac{250 \times 7 \times 22}{7} \times \frac{1600 \times \cdot 126}{60}} =$$

$$\frac{110}{39.27 \times 336} = \frac{110}{132} = \cdot 83\ M$$

Section is $\frac{12469}{32130} = 39\%$

Current is $\frac{110}{39.27} \cdot 4.45 \times$

$4.45 \div 2 = 2 \cdot 225 \times 8\frac{1}{10} = 18.35$

Lake 183 m. in = $\frac{26302}{32130} = 85$ about
Lake 165 x in $\frac{21282}{32130}$ 66% good
We will put 55 ohms on & that will
be R 320 = 149.4 X 55 =
8217 feet X ·306 = 2506 metres
or 1253 metres each core
$\frac{110}{55} = 2 \times 19.36$
1253 metres ÷ ·593 = 2100 Convol.
189 X 3.14 = 593 circum
2100 Convol. ÷ 19 = 110 Cov per layer.
1·24 X 110 = 136 Cont of Cove

Suppose we add 50 ohms of #19 = 115.5

170.88 × 50 = 8544.00 feet or

8544
3.1416
25632
8544
26832.6144 meter

1288 meter each coil.

$\theta = \frac{144}{50} = 2.2 \times 17$ layers = 38 amperes

$146 \times 3.14 = 584$

$1288 \div 584 = 2200$ convol.

$2200 \div 17 = 130$ to core

$130 \times 1.24 =$

1.24
130
372
124
161.20

H machine ⟹ 5 ⟹ Look that ⟹

$M = \frac{E}{L \times V} = \frac{112}{32.82 \times \frac{1200 \times 1.242}{60}}$

$\frac{112}{32.82 \times 1.62} = \frac{112}{119} \quad 119 \overline{)112.0} \; 0.94$

476

32.82
1.62
6566
1966
3282
119.1364

.94 M

H machine May 20th 1894

24 Wires once comm

1200 Rev. 112 V 400 amperes

What is M

$M = \frac{E}{L \times V} =$

$L = 146 \times 2 \times 1 \times 44 = 32.82$

$V = \frac{1200 \times 1.242}{60} = 4.984$

$\frac{112}{32.82 \times 4.984} = \frac{112}{159} = .70$

Section $= \frac{46652}{180532} = 41\%$

~~If we put on 4 200 light coils~~

Current $= \frac{112}{8.38} = 13.5 \div 3 = 4.5$

$4.5 \times 8 = 36$ amperes.

If we put on 2 200 coils each side

Wd Section $= \frac{23326 \times 2 = 46746}{180532} \quad 48\%$

Current $= \frac{112}{7} \; 16 \div 4 = 4 \times 11\frac{1}{4} = 44$ Amp.

Wd put on 2 201 coils of gauge
on 400 amp. 112 Volts.
900 turns

Armature 39 amp per mm

.13 X 4th

10 X 5 11 X 6

60 amperes 50 amperes.
122

6.25 1.7%
51.6
10.3 / 50

3 No 14 Wire Section total 5.4
[illegible]

153
344
612
153
459
48 0 4 3

60 / 4 8 0
8

.008

1.47
4.41
2.60

165
495

1.82
2.1
6.5
12.6 /

R 50 amperes NEW

3 Wires #16 2 times round 60 blocks

11" X 6" 248 X 152

L = 248 X 2 + (152 X 2) X 60

R = L × S.P. / S = 51.600 × .017 / 6.3

.044 + L = .055

4.09
.3.04
16.36
12.27
12 4 8 3 6

124 = 1 ohm

124 / 124
51.6
4 9 6
2 0 6 / 0.42

51.600 - .42 L ÷ 4 = .10.5

Section 248
152
3 0 6
1 3 9 0
2 7 6
4 2 2 5 6

L = (248 X 2 + 152 X 2) X 60 =
(252 X 2 + 156 X 2) X 60 = 52.560 Feet

R. = L × SR ÷ 4 = 52.56 × .017 / 2.16 × 3 ÷ 4 =

.999 / 6.42 ÷ 4 = .155 ÷ 4 = .039 ohms.

HU per square inch

C² × R / Eff S. = 50² × (.039 × 64 1/7%) / 204 effective inch = .30 HU

Wire each core $1.69 \times 45 =$

$$\begin{array}{r} 45 \\ \times\ 1.69 \\ \hline 405 \\ 45 \\ \hline 76.05 \end{array}$$

76.05 lbs.

This R machine will be perfectly good for 66 lamps of .45 amperes

Magnet 60% section + 38 amperes.

$278 \times 152. = \frac{42353}{42250}$

1"

Core ~~145~~ 177

45 ohms #18 wire

$\frac{110}{45} = 2.44$ Amperes

$38 \div 2.44 =$ 16 layers

Amperes per ~~[illegible]~~ in in

$\frac{38}{32} = 1.216$ 2.44 900

Length of Core

45 ohms = 232.6 feet $\times 45 \times .304 = 3182$ Meters

$3182 \div 2 =$ 1591 each core.

$177 + 27.5 = 201 \times 3.14 = .631$ length of one convolution

$\frac{1591 \div .631}{16} =$ no of Convol. per layer. 156.

$156 \times 1.48 = 230$ length of core

add ¼ inch each end and end tracks

Core:- 1 inch diameter

Wound with #18

16 layers

Core 10 inch long over all

EMF =

$1.08 \times \left(\frac{2\pi \times 3 \times 2 \times 60}{8}\right) \times \frac{160 \times .152}{\frac{60}{3}} =$ 80

$108 \times 33.36 \times 1.05 = 143$ Volts

$\frac{138}{356}$

Comparison of weight old R New R.

Iron. = Cores 1/3 of Cond 3841.8 C. inches

Keeper 1/10

Copper Cores 80

Armature 3.

Loss in Magnets

Change of G. 25 amperes.
in Cores

M at present = $\frac{E}{I \times V}$ =

$\frac{110}{(256 \times 2 \times 10 \times 27) \times \frac{1000}{60} \times 126}$ =

$\frac{110}{56.32 \times 378} = \frac{110}{2112} =$ ·52

Weight copper 30 lb.

Weight iron

Present percentage Section $\frac{12469}{32256}$ = ·38 %

" Current round.

$\frac{110}{62} \times 6\frac{1}{2}$ = 11·94

Say we take 6½ iron

Section wire be 165. $\frac{21392}{32256}$ 66 %

Suppose the same wire

30 lb. ÷ 20. in 62 ohm.

Current = 1·77

30 amp. ÷ 1·77 = 21 layers

·165 + 1·07 × 21 167·5 diam average

average length each convolution ·526

9 lb 2 feet = 2815 metre

1408 metre each coil

1408 ÷ ·526 = 2680 convol ÷ 21

128 convolution each layer

G continued:-

128 X 1·1 = 141 ÷ 25 =
166 length of cone.

F Machine Armature
6 No 14 Wires 2 times round
60 Blocks

Current = 1.7 X 12 = 20.4 ▨ m m
100 amp ÷ 20.4 = 4.9 amp per ▨ m m

Radiation per inch

Resistance total .616 ÷ 6 ÷ 4 = .0257
Surface 288 inches

$100^2 \times (.0257 \times 64\%) = 100^2 \times .01645 =$

164.5 H.U. ÷ 288 = .58 HU
per ▨ inch

New York. May 26 1884

H Machine. 500 amperes

Section 500 amperes at 4 per

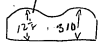
[illegible] m m. = 125 [illegible] mm.

= 62.5 [illegible] m m each side

206 = 20.88 × 3 = 62.64 OK

227

Magnet



Core 275 =

59393 × 2 = 118786

118786 / 202668 = 58%

746 × 246 = 183516

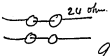
·273

= 64%

Now to send 38 Amperes

Suppose we say 12 ohms

Then



110 / 24 = 4.6 38 / 4.6 =

9 layers of 16 wire

9816 feet = 24 ohms

4908 feet each core

4908 ÷ 9 = 545 feet each layer.

545
.304
2180
1635
166000 | 134
1235 | 166000
1235
42500
37050
5450

134
2.1
134
268
281.4

10¾ diam = circum 33.77
-2.64
15508
10131
102.608

(10¾)
10.750
.707
15.547

(15.5) average
15.5
25.4
620
775
3100
393.70

Diam. 393 = circum 1235
545 feet = 166 meters
= 134 turns =
134 × 2.1 = 281 m

775
160
322
775
740.000

110 | 7.24
47 | 140
161
180

2.340
257.40

142.24
.03
4.27
142.34

92
110
10120

142.34
4.27
110
9963
2846
569.3
6089.8

110 | 7.71
14.25 | 110000
99750
10250
9975
2750

7.71
110
849.1

99.71
.728
79942
19971
69899
725.889

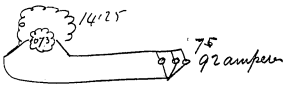
9321
99.73
29913
69797
7.29883

Distribution of energy in old H + New T

May 28 1884

1500 turns

old T



Energy = EI ÷ 9.81 × 440 = foot lbs.

EI	Lamps = 110 × 92 =	10120
	Magnets 110 × 7.71	849.1
	Armature = .073 × (92 + 7.71) = .073 × 99.71 = 7.28 E	
	7.28 × 99.71	725.89
		11694

Lamps 10120 / 11694 =	86.5	
Magnet	07.2	
Armature	06.3	
	100.0	

Dev

$\frac{110}{34} = 110 \div 3.24 = 0.94$

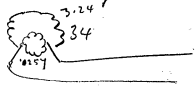
$11620 \,|\, 110000 \div 10467 = 9.42$

$11620 \,|\, 356400 \div 34890 = 10.23$

$11630 \,|\, 2730 \div 2336 = 1.17$

$11630 \,|\, 2730 \div 2336 = 1.17$

New T energy



100

Voltamperes

Lamps 110 X 100 = 11 000

Magnet 110 X 3.24 = 356.40

Armature

@ X R = 100 + 3.24 X .0257 =

E 2.65 X 102.24 = 273.50

$\frac{11000}{11630} =$ 94.5% lamps

Ma 03.0% magnets

02.3 armature

9658 / 87000 / 0.0.8

768640

61360

57942

3412

112

75

8300

9658 / 862200 / 0.09 / 7.7

112

75

8400

7700

8624

82.71

.073

24813

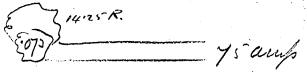
57897

6.03 / 583

82.71

496.26

Old T =



112 Volts

Lamps 112 × 75 =		8300
Magnets $\frac{112}{14.25}$ × 112 =		862
Armature 75 + 7.71 = 82.71		
82.71 × .073 =	6.0	496
6 × 82.71		
		9658

Lamps $\frac{8200}{9658}$	86.3	
Magnets $\frac{862}{9658}$	0.9	
Arm. $\frac{496}{9658}$	4.7	

	Old T %	Mar.
Lamp	86.3 %	94.5 %
Magnet	0.9	3.2 %
Arm.	4.7 %	2.3 %

14665
2514
58625
7333
2
37 2 ~~[illegible]~~ 10 | 195 | 7

14.0000
1665

222
2
2

240350 | 58535000 | 6.24
48070
10465500
9614400
0.41

240350 | 99950 | 0.41
96114
2840
45.6

A | 10
34 | 503 | 34 | 6

110

30 15
E
4 | 110 | 1168 | 220000 | 190
1168
10320
10512

250 ampere
300 turn –

Armature section per
18¾ × 20 long.

300 light core = 18¾ = 27 58535 / 240350 24%
415 × 506
6225
2075
210075

Suppose 355 99950 / 240350 41%

45 amperes ÷ 7 = 7 layers
say 15 ohms.
110 / 15 = #14 = 667 ft per ohm
15
3335
667
10005
1334
9 0 0 2 0
3 8 0 1 5
5 0 4 1 0

or 1520 meter each core
3½ mm = 1.168 each convolution
1520 ÷ 7 = 220 ~~[illegible]~~ meter each
220 ÷ 1.168 = 190 turn × 2.5 =
25
950
3800
4750 = 18¾

250 Ampere machine
300 turns

Armature Iron .507 X .475
~~48 divisions~~ —
2 loops #11 8 each.

Amperes per in in ▨
2.1 amp per ▨ in in

Resistance = 4.4 ÷ 8 ÷ 4 = .137

Heat radiates
C^2 X R X 52% ÷ Surface =
4437 ÷ S =
4437 / 1175 = 4. HU

1. X L X V = E

1 X .507 X 2 X 48 / 5 X 800 X .475 / 60 =

1 X 48.7 X 2.375 = 115 Volts

13.94
1300
6970
418200
42.5170
16

.507
.507
.475
.4664
1992
3.944
31422
15712
4.1850
188.5

42.5 | 1900
1700
2000
6

42.5
2.375
48.7
6625
19000
9500
115.6625

8 | 4.4
4 | 0.55
0.137

8 | 4.4
0.55

.507
1.014
8.112
4056
4.8177

1395
1.304
5580
4185
424000

8/56
4/107
011 9

62500
.0075
31250
43750
468/5000

50/14
10950
19064
3 19 64
1 5 7 6 8
2 5 1 3 9 2

62500
56 2500

424 | 25100 / 21200 / 3900 / 3816 | 0.59

1395 feet = 1 ohm = .424 metre

190 Metres

424
190

424/1800/0.45
2040

.45 ÷ 8 ÷ 4

8/.45
4/05 75
0.1 4 4 Resist

.014
45
56

CO_2 X R X 52%

62500 X .0075 = 468
1175/4680/0.4

62500 X .009 =
1175/5620/0.5

2000 lb 011

48

6194.6

250
80
12500
50000
6250000
10727
4375000
6250000
7937500

7.292 / 87.48 | 250000 / 17496 / 175040 | 2.8

6.59
4.0983
.0245

.0244
1.044
4056
6084
6.8890

.0245
.52
890
1225
.01290

250 Ampere Slow speed

Suppose 64 blocks
& 6 wires 2 times round

∴

Amperes per mm will be 2.8

Resistance = .59 ÷ 6 ÷ 4 = .0245

Heat U.

$C^2 \times R \times 52\% \div 1175 =$

493
1175 | 7930 | .6740
8800

$1 \times \frac{.507 \times 2 \times 64}{2} \times \frac{.245 \times .475}{60}$

65 × 2.375
65
11875
14250
154.375

14

154 Volts

June 2

Slow speed 250 amperes.

Magnet

10% core = 24% section

Multiple arc the cores —

We want 80 amperes through there

10 ohms total = $\frac{110}{10}$ = 11 amperes

~~00~~ $5\frac{1}{2} \times x = 80$ amp

$x = 15$ layers.

each core

20 ohms

15 layers

$5\frac{1}{2}$ amperes

Say just #14 wire nearly

2 amp per m m

Then one convolution =

$.273 + 2.5 \times 15$

$.37$

$.310$ 310 cent. = .974

Length

20 ohms 667 feet per ohm

$667 \times .304 = 203$ metres $\times 20$

$15 \overline{)4060}$ each core

271 each layer

$271 \times .974 = 279$ Convolutions per layer

$.974 \overline{)271.000} \quad 279$

1948

7620

4792

$279 \times 2.5 = .697$ length of Core

279

15

1395

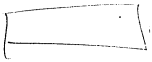
558

697

1758 / 12.000 / 1758 / 6.1

15
750

12716 / 12.000 / 2.4 / 7.5



700

Slow Speed 250 amp
See what we get with the
wire that is in

Arc lamp machine June 3 1884

Lake 50 light machine —
Wind armature with

June 6 1884

300 Rev. 250 ampere

Now we have supposed armature 6 #11 wires 2 time round + 64 blocks

Now how does the answer the requirements?

{ 1 Resistance = ·0026 Resist

{ Resistance effective = ·0026 × 52% = ·0135

{ Amperes per mm = 2·83

{ Heat Units per inch surface $\frac{C^2 \times R \times 52\%}{1130} = \frac{944}{1130}$ ·72.

Now experiment shows me that I must have 50 per cent section at least and 45 amperes of current

Now if we take 14 nos

which is 355 Diam + Section

98980
231699 43%

15" = 380 = 113411 = 49%

Will take 14" 43%

Now to pass 40 amperes current
#16 Wire in 10 layers

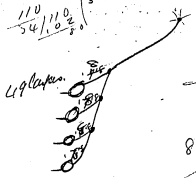
355 +
18
373 = 1.171 one convolution
Diam

27.5 ohms = 124.4 X 27.5 =
3421 meters each core
or 342 " " layer.
or 292 convolution per layer
292 X 1.87 = 534 diam. or
21 inch 22" over all

Now suppose we say 14" core
and 5 amperes current.

5 amperes X 10 layers.
#15 = 2.1 diam.
Current 5 Resistance 22 ohms.
11 ohms each ~~layer~~ core
502. feet per ohm = 152.6
Diam 1 convolution 3.75 = 1.178 Circ
152.6 X 22 3357 meters
= 1678 on each core
or 168 on each layer
168 X 2.1 352 or 14"

110 / 54 | 110 / 102 / 80 | 3.2



3.2
12
38.4

80
80
640

.76 / 38.40 / 49
31 2
72 0
72

Drain .81

□ .397

22 = 76 feet per Ohm

Drain = 80 + .81 × 49
40
120

49
81
2 6 4
40.57

120 = .377

1564 meter each core
32 meter each layer
90 cover.
90 × .81 =

100 ampere machine
Weight of cross & Keeper
Weight of head
total

179
330
5370
5370
6107.0

50 = 1963 × 5 = 9515
80 = 5026 × 4 20106
6400 25600

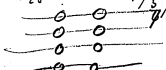
46
46
8

.304
76
1824
2128
23104

23
65
115
138
1564

110 / 3.2 = 134.33 / 32 / 98

3 · □
1.5 / 1.5
.20



68 ohms on each

80 / 1564 / 32

377 / 32000 / 3393 / 90

July 18 1884

Alteration on the S.

Can we put more section on the Armature.

~~·246 × 3·14 = ·772~~

·64 division at ·042 =

9.69 × 3.14 30·426

·042 × 64 = 2·688

64 | 27·738 | 0·434

256

213

192

212

·434 in each division —

#16 = ·065 + 20 = ·085 × 5 ·425

#15 = ·072 + 20 = ·090 × 5 = ·450

10 #16 = 42250

10 #15 51040

Drain 9.690 × 3·14 30·426

64 division at ·042 2·688

27·738

27·738 ÷ 64

·433 — space for each

#14 8 = 55112 ample

·083 + 20 = ·103 × 4 = ·412

∴ We use 8 No 14 wire instead of 10 No 16

Percentage Section —

Armature ·419 × ·246 = 103074

Core ·234² × 3·14/4 = 60800

= 41%

If we take 11" core we have

2·48² × 3·14/4 = 4772.84 =

= 45%

If we take 10 core

2·54² × 3·14/4 = 50645

= 49%.

If we take 10½"

2·66² × 3·14/4 55544 =

= about 53

If we take 10¾"

2·73² × 3·14/4 58505.

= 57%

Now for the wire 20 ohms resist

~~44 8 amperes.~~

= 110/20 = 5·5 amperes

About 8 layers

Amperes layers
5.5 X 8 = 44
We b carry 5.5 amperes at most
more than 3 amp per m m =
#16 =
20 ohms #16 = 409.276 feet X 20 =
409.276 X .3048 X 20
2450 metres of wire
12.40 each layer
155 metre each layer
Core 273 X 3.14 857
155 ÷ 857 181 turns to layer
.079 X 181 = 14.3 inches long
14.3 + 1 = 15.3 total

~~Amperes spires~~
~~in old 200 S.~~
~~$\frac{110}{14.06}$ X 277 X 11 3/4 =~~
~~7.8 X 277 X 11 3/4 239.220~~
~~in new. 200~~
~~5.5 X 8 X 181 X 2. 15.928~~

old S. 94 lb 7 each = 28.3 ohms
or 56 ohms.
In multiplying are the ampere spires
ought be. 12.690
~~7.8~~ X 277 X 11 3/4 ~~25.381~~

Take #16 wire and ~~[illegible]~~ 30 ohms
78.8 lbs. each core
30 ohms = 409.3 X 30 X .3048 =
3743 metres =
1871 metres each core
3.66 X 11 = 40.26
11 layers.
1871 metres ÷ 11 = 170 turns each
170 turns X 2.1 = 357 m m length
14 1/5 inch
with insulation 15 5/8.
Ampere spires :-
3.66 X 11 X 170 X 2 = 13.688.

Take 94 lbs #16 =
.1268 X 94 = 12 ohms about
Amperes $\frac{110}{12}$ 110 = 9.17 amp.
#18 = 2.486
9.17 ÷ 2.486 = 3.7 too much

Suppose we take same wire
194 lb. #14 = 28·3 ohms
56·6 ohms

altogether
326 × 56·6 × ·3048 = 5624 metres
2812 metres each wire
10 layers: would be 281 metres per layer
273 × 3·14 = ·857
281· ÷ ·857 = 328 each layer
328 × 1·83 =

---

12 layers = 2812 ÷ 12 = 234 turns per lay
231 ÷ ·857 = 270 turns
270 turns × 1·83 494 or 20 metres
Ampere ofwire
7·86 × 270 × 12 = — ~~254664~~ 12752

Amp layers $\frac{7.86}{2}$ × 12 = 3·93 × 12 =
46.16 —

Suppose we say 110 lb #16 each wire
= ·191 × 110 = 21,010 ohms
$\frac{110}{21}$ = 5·24 ampere
length ·409 × ·3048 × 21 = metres
2617

---

110 lb. #16 each wire
220 lb. wire = ·191 × 220 = 42 ohms
$\frac{42}{4}$ = 10·50 ampere

21 ohms each wire
409 × ·3048 × 21 = metres 2616
in 12 layers = 218 ~~metres~~ —
273 × 3·14
218 ÷ ·857 = 254 turns
254 × ~~2~~ turns ·508 or 20 metres

Ampere ofwire
$\frac{10.50}{2}$ 12 × 254 =
5·25 × 3000
15750

Then we say

10 ¾ core 20 inches long

Wound with 12 layers

No 16 Wire 110 lbs each

core

The 175 ampère machine

with 300 revolutions 110 V.

4 wires #11 = 7.3 × 8 =

58.4 m m

$\frac{175}{58.4}$ = 3 amperes per m m

Good

1.07 m m = insulation

1.07 × 64 = 68.48 m m

3.56 m m each wire

Diameter =

$\frac{68.48 \text{ mm} + (3.56 \times 4 \times 64)}{3.14} =$

$\frac{979.84}{3.14}$ = .312 diameter

[ITEM FOUND IN BOOK]

12 #11 Wire = 87.6 m m

m m □ 4.3 × 12 =

87.6 / 250 = 2500 / 1752) 2.83

2480
7200
2720

2.83 Amp per m m.

8 #11 Wires = 58.4

58.4 / 1750 / 1752) 3.

.042
2514
168
210
.0668

Drain 460 × 3.14

314
1840
460
1380
144440

.042
64

1.07
64
428
642
68.48

120
20
1140
2514
5660
700
2800
3.5660